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CONTAMINANTS AND FISH-EATING OSPREY NESTING ALONG THE LOWER COLUMBIA RIVER, 1997/1998 AND 2004

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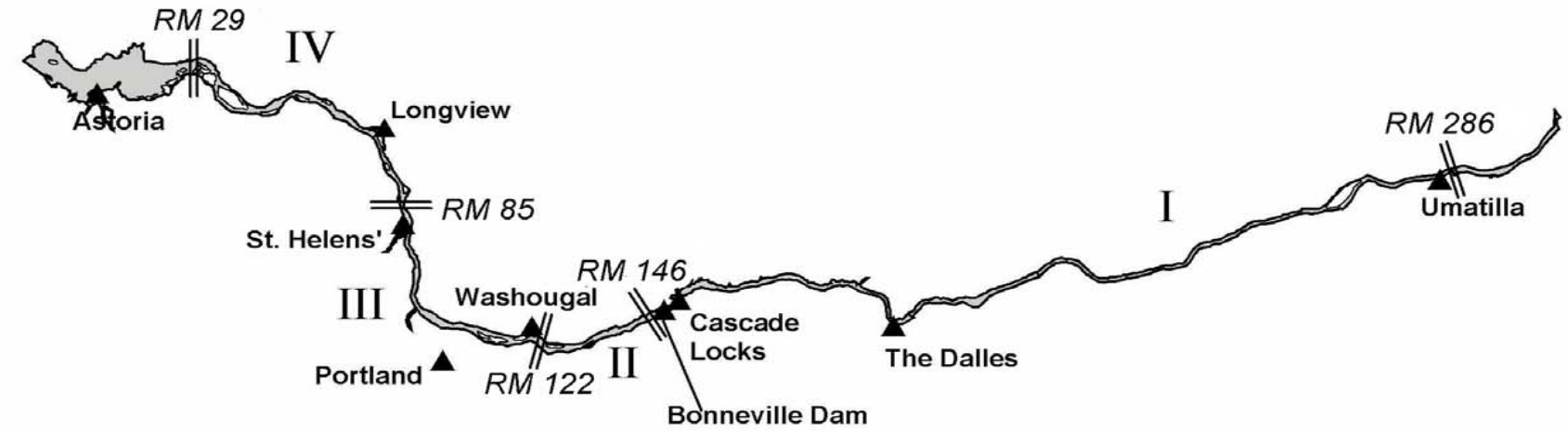
Why Select Ospreys as Sentinel Species

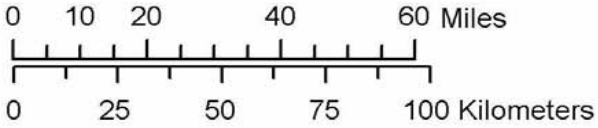




- Worldwide distribution (comparable data many locations)
- Diet almost exclusively live fish captured near the nest
- Long-lived and high nest fidelity.
- Large stick nests easily located and spaced at regular intervals along rivers
- Nests on artificial structures in urban areas with easy nest access
- Tolerates short-term nest disturbance during collection of sample egg
- Sensitive to many contaminants with “effect concentrations” known.
- Lay extra egg which is rarely fledged (sample egg collection has minimal effect)


RM 29
IV
Astoria
Longview
RM 286
RM 85
I
Umatilla
St. Helens'
RM 146
III
Washougal
Cascade
Locks
The Dalles
Portland
RM 122
II
Bonneville Dam


Washington
Study Area
Oregon


0 10 20 40 60 Miles
0 25 50 75 100 Kilometers

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Osprey nesting success along the Lower Columbia River, 1997/1998 and 2004.

Category	1997/1998[a]	2004
Young/Occupied Nest[b]		
Reach I	1.47	1.86
Reach II	1.23	1.29
Reach III	1.46	1.74
Reach IV	1.79	1.37
Combined	1.54	1.59
Young/Successful Nest[b]		
Reach I	1.90	2.37
Reach II	2.24	2.27
Reach III	2.17	2.50
Reach IV	2.16	2.23
Combined	2.11	2.35

Note: The generally accepted reproductive rate necessary to maintain a stable Osprey population is 0.80 young/occupied nest.

[a] From Henny et al. (2004), Raptors Worldwide.

[b] Nests without and egg collected.

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Osprey nesting pairs (pairs/river mile) by reach along the Lower Columbia River, 1997, 1998 and 2004.

Occupied Nests	1997	1998	2004
Reach I	21 (0.15)	24 (0.17)	57 (0.41)
Reach II	17 (0.81)	19 (0.90)	28 (1.33)
Reach III	29 (0.78)	29 (0.78)	59 (1.59)
Reach IV	27 (0.49)	31 (0.56)	81 (1.47)
Combined	94	103 (9.6%)[a]	225 (13.9%)[b]

Note: Length of Columbia Reaches: I (140 miles), II (21 miles), III (37 miles), IV (55 miles).

[a] Annual rate of population increase.

[b] Average annual rate of population increase.

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Comparison of mercury and organochlorine pesticides in Osprey eggs by river reach from the Lower Columbia River, 2004.

	River Reach (geometric mean)				
Contaminant	I	II	III	IV	Combined (extremes)
N	9	9	11	11	40
Mercury	0.35 A	0.40 A	0.52 A	0.51 A	0.45 (0.16-1.01)
DDE	1705 A	1487 A	1481 A	1449 A	1521 (985-2294)
DDD	91.6 A	61.5 A	67.8 A	63.5 A	69.7 (23.9-281)
DDT	7.56 A	6.00 A	3.96 A	3.65 A	4.92 (0.74-43.9)
HCB	1.62 A	2.54 A	1.22 A	1.88 A	1.73 (0.68-184)
β-HCH	0.25 A	0.20 A	0.28 A	0.39 A	0.28 (ND-2.17)
Total Chlordanes[a]	15.9 A	13.2 A	14.1 A	15.5 A	14.7 (4.08-108)
Heptachlor Epoxide	2.48 A	2.57 A	2.87 A	2.92 A	2.72 (1.03-14.3)
Dieldrin	0.69 B	1.63 AB	2.19 A	1.57 AB	1.44 (0.34-8.12)

Note: No significant differences among river reaches in 1997/1998.

Mercury (ppm, dw), organochlorine contaminants (ppb, ww). ND = not detected. Values in rows sharing the same letters are not statistically significant.

[a] Total chordanes = Σ *trans*-nonachlor, *cis*-nonachlor, oxychlordane, *trans*-chlordane and *cis*-chlordane.

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Comparison of mercury and organochlorine pesticides in Osprey eggs by collection years 1997/1998 and 2004 from the Lower Columbia River

Contaminant	1997/1998	2004	P
Mercury	0.29 B	0.45 A	0.0028
DDE	4872 A	1521 B	<0.0001
DDD	199 A	69.7 B	<0.0001
DDT	19.8 A	4.92 B	0.0006
HCB	3.66 A	1.73 B	0.0002
β-HCH	0.43 A	0.28 A	0.1685
Chlordanes[a]	26.8 A	14.7 B	0.0004
Heptachlor Epoxide	7.21 A	2.72 B	<0.0001
Dieldrin	6.47 A	1.44 B	<0.0001

Note: N=29 for 1997/1998 and N=40 for 2004. Mercury in ppm (dw) and OCs in pbb (ww). Values in rows sharing the same letter are not statistically significant.

[a] Total chlordanes = Σ *trans*-nonachlor, *cis*-nonachlor, oxychlordane, *trans*-chlordane and *cis*-chlordane.

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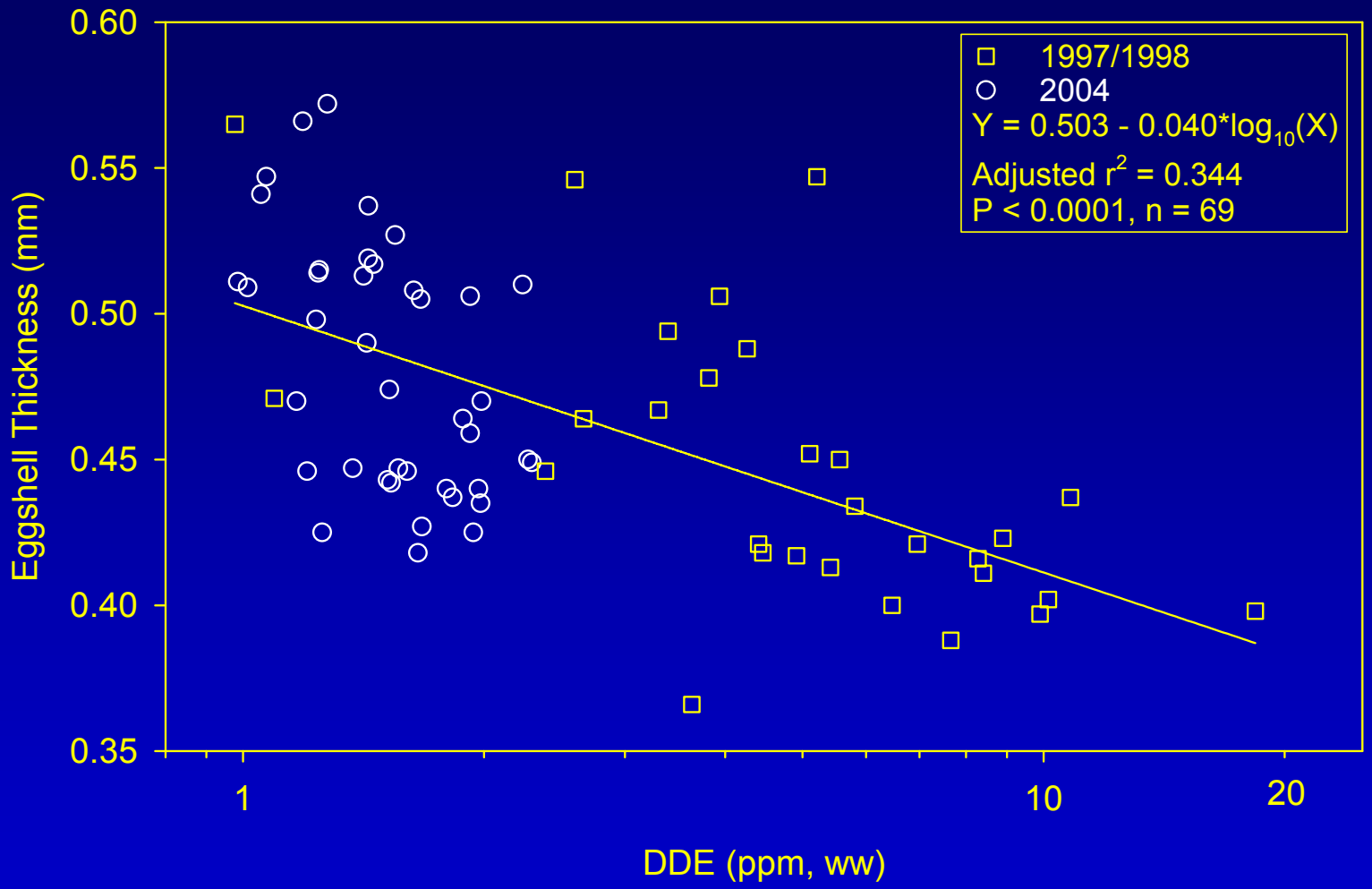
Osprey young produced per nest (with one egg collected) in relation to DDE concentrations in the sample egg collected and eggshell thickness (Lower Columbia River 1997, 1998 and Willamette River 1993).

	Number of Nests with DDE (PPB, ww)		
Category	<4200	4200-8000	>8000
Number of Nests	18	12	8
Young/Nest	1.61	1.25	1.00
Geometric Mean DDE (ppb)	2131	5473	10510
Mean Shell Thickness (mm)	0.488	0.441	0.419
Percent Shell Thinning[a]	-3.4	-12.7	-17.0

[a] Compared to 0.505 mm for pre-DDT era eggshells from eastern USA.

Note: The highest DDE concentration in the Lower Columbia River in 2004 was 2294 ppb (ww).



Relationship between DDE concentrations (ppm) and eggshell thickness (mm) of Osprey eggs from the Lower Columbia River, 1997/1998 and 2004.

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Comparison of PCB concentrations in Osprey eggs by River Reach from the Lower Columbia River, 2004.

Contaminant	River Reach (geometric mean)				
	I	II	III	IV	Combined (extremes)
N	9	9	11	11	40
ΣPCBs[a]	492 A	841 A	828 A	1022 A	783 (159-8419)
Aroclor 1254:1260	1005 A	1997 A	1793 A	2284 A	1723 (354-13932)
PCB 77	194 A	131 A	134 A	334 A	186 (25.9-2512)
PCB 81	14.0 A	24.4 A	30.0 A	53.6 A	28.3 (ND-358)
PCB 126	164 A	212 A	179 A	291 A	208 (25.9-6931)
PCB 169	18.9 A	27.1 A	16.5 A	26.7 A	21.7 (4.39-218)
PCB 99	12.5 B	27.7 A	25.0 AB	32.4 A	23.5 (3.98-122)
PCB 118	38.0 A	78.5 A	66.2 A	78.7 A	63.7 (11.7-1002)
PCB 153	91.5 A	154 A	144 A	188 A	142 (29.8-1028)
PCB 105	3.36 A	7.73 A	5.65 A	3.70 A	4.80 (0.13-20.2)
PCB 138	73.3 A	146 A	132 A	163 A	125 (25.8-1017)
PCB 183	11.7 A	19.3 A	20.2 A	25.8 A	18.9 (3.10-182)
PCB 180	44.2 A	77.9 A	80.7 A	99.0 A	74.0 (11.9-611)
PCB TEQs[b]	33.4 A	32.5 A	29.7 A	54.1 A	36.7 (6.64-866)

Note: No significant differences among River Reaches in 1997-1998, except PCB 105 which was significantly higher in Reach II than in Reaches I or III.

PCB contaminants (ppb ww, except for PCBs 77, 81, 126 and 169 ppt ww) and PCB TEQs (ppt, ww). ND = not detected. Values in rows sharing the same letters are not statistically significant.

[a] Sum of 42 congeners.

[b] Van den Berg et al. (1998), Environ. Health Perspect.

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Comparison of PCB concentrations in Osprey eggs by collection years 1997/1998 and 2004 from the Lower Columbia River

PCB	1997/1998	2004	P
ΣPCBs[a]	1435 A	783 B	0.0013
Aroclor 1254:1260	3002 A	1723 B	0.0033
PCB 77	199 A	186 A	0.7319
PCB 81	15.8 A	28.3 A	0.1759
PCB 126	302 A	208 A	0.0636
PCB 169	20.1 A	21.7 A	0.7419
PCB 99	53.3 A	23.5 B	<0.0001
PCB118	130 A	63.7 B	0.0005
PCB 153	242 A	142 B	0.0026
PCB 105	36.6 A	4.80 B	<0.0001
PCB 138	222 A	125 B	0.0024
PCB 183	30.5 A	18.9 B	0.0153
PCB 180	120 A	74.0 B	0.0210
PCB TEQ	50.0 A	36.7 A	0.0959

Note: N=29 for 1997/1998 and N=40 for 2004. PCBs in ppb (ww), except PCBs 77, 81, 126, 169 and PCB TEQs which are in ppt (ww) . Values in rows sharing the same letter are not statistically significant.

[a] Sum of 42 congeners.

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Comparison of dioxin concentrations in Osprey eggs by River Reach from the Lower Columbia River, 2004.

	River Reach (geometric mean)				
Contaminant	I	II	III	IV	Combined (extremes)
N	9	9	11	11	40
2378 TCDD	2.20 A	1.46 A	0.64 B	0.64 AB	1.18 (0.27-17.8)
12378 PeCDD	1.66 AB	2.99 A	1.17 AB	0.52 B	1.25 (ND-13.4)
123478 HxCDD	NC	0.18 A	0.11 A	NC	NC (ND-4.87)
123678 HxCDD	8.69 A	4.21 AB	2.05 BC	1.65 C	3.14 (2.00-23.7)
123789 HxCDD	2.98 A	1.14 AB	0.49 B	0.47 B	0.88 (0.10-9.94)
Total HxCDD	13.0 A	6.00 AB	2.88 BC	2.50 C	4.59 (0.68-32.5)
1234678 HpCDD	52.3 A	10.3 AB	4.39 BC	1.38 C	6.76 (ND-222)
Total HpCDD	52.5 A	10.3 AB	4.39 BC	1.39 C	6.78 (ND-222)
OCDD	83.9 A	25.9 AB	10.5 BC	3.34 C	15.0 (0.96-896)
Dioxin TEQS	6.07 A	5.63 A	2.67 B	2.67 B	3.80 (1.18-23.0)

Note: No significant differences among river reaches in 1997/1998, except OCDD which was significantly higher in Reach III than in Reach IV.

Dioxin contaminants (ppt, ww). NC = not calculated, contaminant detected in < 50% of eggs. ND = not detected. Values in rows sharing the same letters are not statistically significant.

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Comparison of dioxin concentrations in Osprey eggs by collection years 1997/1998 and 2004 from the Lower Columbia River

Dioxin	1997/1998	2004	P
2378 TCDD	4.09 A	1.18 B	<0.0001
12378 PeCDD	1.53 A	1.25 A	0.6362
123678 HxCDD	3.03 A	3.14 A	0.9246
123789 HxCDD	0.49 A	0.88 A	0.1116
Total HxCDD	7.52 A	4.59 A	0.0658
1234678 HpCDD	16.3 A	6.76 B	0.0331
Total HpCDD	18.0 A	6.78 B	0.0208
OCDD	78.7 A	15.0 B	0.0002
Dioxin TEQ	12.4 A	3.80 B	<0.0001

Note: N=29 for 1997/1998 and N=40 for 2004. Dioxins and dioxin TEQ in ppt (ww). Values in rows sharing the same letter are not statistically significant.

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Comparison of furan concentrations in Osprey eggs by River Reach from the Lower Columbia River, 2004.

	River Reach (geometric mean)				
Contaminant	I	II	III	IV	Combined (extremes)
N	9	9	11	11	40
2378 TCDF	1.23 A	0.64 AB	0.26 B	0.58 AB	0.56 (ND-4.94)
Total TCDF	1.26 A	0.69 A	0.27 B	0.88 A	0.65 (0.08-4.94)
23478 PeCDF	0.56 A	1.72 A	0.60 A	0.65 A	0.76 (ND-27.5)
Total PeCDF	1.55 A	2.03 A	0.68 A	0.71 A	1.06 (ND-28.1)
123478 HxCDF	0.63 A	0.42 AB	0.20 AB	0.11 B	0.26 (ND-4.11)
234678 HxCDF	0.46 A	0.29 AB	0.12 AB	0.09 B	0.18 (ND-2.25)
123678 HxCDF	0.62 A	0.52 A	0.13 B	0.10 B	0.23 (ND-3.78)
Total HxCDF	1.75 A	1.74 A	0.54 AB	0.33 B	0.80 (ND-10.7)
1234678 HpCDD	NC	NC	NC	NC	NC (ND-2.59)
1234789 HpCDF	NC	NC	NC	NC	NC (ND-2.70)
Total HpCDF	0.49 A	0.14 A	NC	NC	0.16 (ND-28.26)
OCDF	0.21 A	0.15 A	0.08 A	NC	0.11 (ND-11.4)
Furan TEQS	2.95 A	2.66 A	0.94 B	1.46 AB	2.64 (0.22-29.3)
Combined TEQs[a]	47.4 A	40.9 A	32.8 A	57.9 A	43.8 (9.86-910)

Furan contaminants and TEQs (ppt, ww). NC = not calculated, contaminant detected in < 50% of eggs. ND = not detected. Values in rows sharing the same letters are not statistically significant.

[a] Includes PCB, dioxin and furan TEQs. NOAEL for Ospreys, 136 ppt, ww, Woodford et al. (1998), Environ. Toxicol. Chem.

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Comparison of furan concentrations in Osprey eggs by collection years 1997/1998 and 2004 from the Lower Columbia River

Dioxin	1997/1998	2004	P
2378 TCDF	0.96 A	0.56 A	0.1203
Total TCDF	1.59 A	0.65 B	0.0098
23478 PeCDF	NC	0.76	NC
Total PeCDF	1.85 A	1.06 A	0.1707
123478 HxCDF	0.20 A	0.26 A	0.4648
Total HxCDF	1.09 A	0.80 A	0.4374
Total HpCDF	0.61 A	0.16 B	0.0097
OCDF	0.24 A	0.11 B	0.0443
Furan TEQ	1.48 A	1.74 A	0.6838
Total TEQs[a]	62.5 A	43.8 B	0.0385

Note: N=29 for 1997/1998 and N=40 for 2004. NC = not calculated. Furans and furan TEQ in ppt (ww). Values in rows sharing the same letter are not statistically significant.

[a] Includes PCBs, dioxins and furans

Biomagnification Factors (BMFs) from fish (whole body, wet weight and lipid weight) to Osprey eggs for organochlorines and PCB congeners and dry weight for mercury from the Upper Willamette River, 1993 vs. 2001.

	Biomagnification Factors			
	1993		2001	
Category	Wet Weight[a]	Lipid Weight	Wet Weight	Lipid Weight
HCB	1.2	1.4	1.5	2.4
p, p´-DDE	87	103	79	113
p, p´-DDD	23	28	18	25
Mirex	35	49	NC	NC
Total Chlordanes	4.3	5.7	2.8	4.0
p, p´-DDT	47	62	NC	NC
HE	25	28	NC	NC
Dieldrin	6.7	7.9	3.3	5.0
Mercury	NA[b]	NA[b]	0.71[c]	[c]
PCB77	3.3	4.0	2.2	3.2
PCB81	NA[b]	NA[b]	12	18
PCB126	15	18	1.3	1.8
PCB169	12	12	34	48
PCB99	7.4	9.2	7.5	11
PCB 118	11	13	15	22
PCB153	16	19	11	16
PCB138	16	19	11	16
PCB105	13	16	3.5	5.3
PCB182/187	14	18	14	20
PCB183	15	18	16	23
PCB180	19	22	17	24
ΣPCBs	11	13	8.4	12

Note: HE= heptachlor epoxide; HCB= hexachlorobenzene; NC= not calculated, residue in fish or Osprey eggs below detection limits.

[a] From Henny et al. (2003).

[b] Osprey eggs not analyzed for contaminant in 1993 (NA= Not analyzed)

[c] Based on dry weight concentrations, lipid not appropriate for mercury.

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